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(54) Printing apparatus and printing method

(57) A printing apparatus for forming a color image by applying different color inks to a printing material while bi-directionally moving the recording head to scan the recording material, the apparatus includes changing means for changing an order of applications of the inks to be applied for printing a secondary color to a secondary color pixel area; forming means for forming the secondary color while making the order of applications of the inks to at least one of a plurality of the secondary color pixel areas arranged along a raster scan direction different from the order of another, by the changing means.

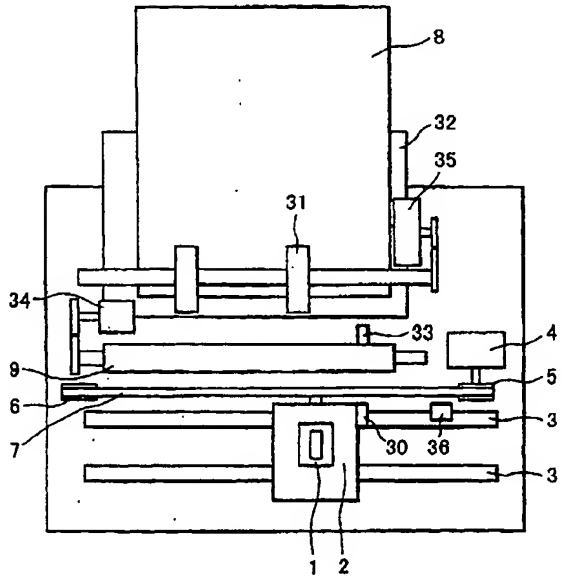

FIG. 1

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printing method and a print wherein the color non-uniformity attributable to the scanning directions can be reduced even if a bi-directional color print is carried out.

[0012] It is another object of the present invention to provide a printing apparatus, a printing method and a print wherein the occurrence of the color non-uniformity attributable to the scanning direction irrespective of the print data.

[0013] It is a further object of the present invention to provide a printing apparatus, a printing method and print wherein the occurrence of the color non-uniformity attributable to the scanning direction can be reduced in a low density portion and a high density portion.

[0014] According to an aspect of the present invention, there is provided a printing apparatus for forming a color image by applying different color inks to a printing material while bi-directionally moving the recording head to scan the recording material, said apparatus comprising changing means for changing an order of applications of the inks to be applied for printing a secondary color to a secondary color pixel area; forming means for forming the secondary color while making the order of applications of the inks to at least one of a plurality of the secondary color pixel areas arranged along a raster scan direction different from the order of another, by said changing means.

[0015] According to another aspect of the present invention, there is provided a printing apparatus for forming a color image by application of different color inks onto a printing material while bi-directionally moving the recording head to scan the printing material, said recording head having one or more sets of recording elements arranged in a scanning direction symmetrically, said apparatus comprising print buffers each corresponding to the symmetrically arranged recording elements constituting the set; and distributing means for distributing print data for a color to at least one of the print buffers on the basis of an image signal corresponding to the color image.

[0016] According to a further aspect of the present invention, there is provided a printing apparatus for forming a color image by application of different color inks to a printing material while bi-directionally moving the recording head to scan the recording material, said apparatus comprising changing means for changing an order of applications of inks of different colors to formation a process color in a process color pixel area; forming means for forming the process color by making an order of applications of the inks to at least of the secondary color pixel areas arranged in a raster one direction different from the order of another, by said changing means.

[0017] According to a further aspect of the present invention, there is provided a printing method for forming a color image by application of different color inks onto a printing material while bi-directionally moving the recording head to scan the printing material, said method comprising a first step of application of different color inks to form a secondary color in a secondary color pixel area in an order of applications; a second step of application of different color inks to form the secondary color in the secondary color pixel area in an order of applications which is different from the order in the first step;

[0018] According to a further aspect of the present invention, there is provided a print having a color image provided by different color inks, comprising a printing material; a plurality of secondary color pixel areas arranged in a predetermined direction on the printing material; wherein the plurality of pixel areas are printed by different color inks, and wherein an order of applications of the inks to at least one of the pixel areas is different from the order of another.

[0019] According to a further aspect of the present invention, there is provided a print having a color image provided by color ink of a first color and ink of a second color, comprising a printing material; a solid secondary color area thereon, said solid secondary color area including first secondary color portions and second secondary color portions appearing substantially alternately on the recording material, microscopically, wherein said first secondary color portions are provided by the inks of the first color and the second color and has the secondary color of a first-color-rich nature, and said first color portions are provided by the same different color inks and has the secondary color of a second-color-rich nature.

[0020] With such a structure, the pixel areas of a process color including a secondary color, arranged in the raster scan direction, are dominantly provided by application of the inks in different application orders, and therefore, the orders of applications are substantially the same irrespective of the scanning directions so that generation of the color non-uniformity attributable to the order of applications of the inks can be reduced.

[0021] In this specification, "print" or "recording" includes formation, on a recording material, of significant or non-significant information such as an image, a pattern, character, figure and the like, and processing of a material on the basis of such information, visualized or non-visualized manner.

[0022] Here, the "recording or printing material" includes paper used in a normal printer, textile, plastic resin material, film material, metal plate and the like which can receive ink.

[0023] Here, "ink or liquid" includes liquid usable with the "print" or "recording" defined above, and liquid usable to formation of an image, patter or the like on the printing material or to processing of the printing material.

[0024] The term "pixel area" means a minimum area where a primary color or secondary color is provided by application of one of more inks, and is not limited to a pixel but includes a super pixel or a sub-pixel. The number of scannings to complete the pixel area is not limited to one but may be plural.

[0025] The term "process color" includes secondary colors, and means a color provided by mixing three or

[0055] Figure 25 shows another example a recording head and an allotment of ejection nozzles.

[0056] Figure 26 shows a further example of a recording head and an allotment of ejection nozzles.

[0057] Figure 27 shows a further example of a recording head and an allotment of ejection nozzles.

[0058] Figure 28 shows a further example of a recording head and an allotment of ejection nozzles.

[0059] Figure 29 shows a further example of a recording head and an allotment of ejection nozzles.

[0060] Figure 30 is a schematic view of gradation from monochromatic Y, M, C color printed on the print medium to a secondary color.

DESCRIPTION OF THE PREFERRED EMBODIMENTS:

[0061] The description will be made as to the embodiments of the present invention. In the Figures, the same reference numerals are assigned to the elements having the corresponding functions.

[0062] Figure 1 shows a structure of a major part of an ink jet printing apparatus according to an embodiment of the present invention.

[0063] As shown in Figure 1, a cartridge 1 is exchangeably mounted on a carriage 2. The head cartridge 1 comprises a print head portion, an ink container portion and a connector portion for receiving and supplying signals for driving the head portion (unshown).

[0064] The head cartridge 1 is carried on the carriage 2 at a correct position and is exchangeable, and the carriage 2 is provided with a connector portion and a holder (electrical connecting portion) for transmission of the driving signals or the like to the head cartridges 1 through the connector.

[0065] The carriage 2 is reciprocably supported and guided by a shaft 3 and a guide of the main assembly of the apparatus, which is extended in a main scan direction. The carriage 2 is driven through a driving mechanism such as a motor, a pulley 5, a driven pulley 6, a timing belt 7 or the like by a main-scanning motor 4, and the position and the movement are controlled. A home position sensor 30 is carried on a carriage. By this, the position of the carriage 2 can be detected when the home position sensor 30 of the carriage 2 passes by the shielding plate 36.

[0066] The print mediums 8 in the form of a print sheet, thin plastic resin sheet or the like are fed out one by one from the automatic sheet feeder ("ASF") by rotating the pick-up roller 31 through a gear by a sheet feeding motor 35. By rotation of the feeding roller 9, the sheet is fed through (scanned by) a position (print portion) where the sheet is opposed to the ejection outlets of the head cartridge 1. The feeding roller 9 is rotated through the gear by rotation of the LF motor 34. At this time, the discrimination of the sheet feeding and the determination of the leading edge of the sheet is effected by the timing at which the print medium 8 passes by the paper end sensor 33. The paper end sensor 33 is also effective to detect the actual position of the trailing edge of the print medium 8 and to make the final determination of the current recording position.

[0067] The print medium 8 is supported by a platen (unshown) at its back side so as to provide a flat print surface at the print portion. The heads and cartridges 1 on the carriage 2 are supported such that ejection side surfaces thereof are faced downward in parallelism with the print medium 8 between the feeding rollers constituting a pair.

[0068] The head cartridge 1 is an ink jet head cartridge which ejects the ink using the thermal energy, and is provided with electrothermal transducers for generating thermal energy. In this example, the print head of the head cartridge 1 ejects the ink through the ejection outlet using the pressure of the bubble generated by film boiling caused by the thermal energy applied by the electrothermal transducer. Another type using a piezoelectric element to eject the ink, or the like is usable.

[0069] Figure 2 is a block diagram of a control circuit in the ink jet printing apparatus.

[0070] In these Figure, a controller 200 is a main controller, and comprises a CPU201 (a micro computer or the like), ROM203 storing a program, a table, fixed data or the like, and RAM205 having an area for conversion of image data and a wording area. The host apparatus 210 may be a supply source of image data (a computer for carrying out production and processing of data such as image to be printed, or a reader portion for reading the image to be printed, or the like). The image data, command, a status signal or the like are transmitted to and from the controller 200 through the interface (I/F) 212.

[0071] The operating portion 120 includes a group of switches for actuation by the operator, and includes a main switch 222, a recovery switch 226 for instructing the start of the suction refreshing operation.

[0072] A group of sensors includes sensors for detecting states of the apparatus, more particularly, the above-described home position sensor 30, a paper end sensor 33 for detecting presence or absence of the print medium and a temperature sensors 234 or the like disposed at proper positions for detecting the ambient temperatures.

[0073] The head driver 240 is a driver for actuating the ejection heater 25 of the print head 1 in accordance with the print data. The head driver 240 includes a shift register for aligning the print data corresponding to the positions of the ejection heater 25, a latching circuit for effecting latching at proper timing, a logic circuit element for actuating the ejection heaters in synchronism with the drive timing signal, and a timing setting portion for appropriately setting the drive timing (ejection timing) for dot formation and position alignment, or the like.

[0074] The print head 1 is provided with a sub-heater 242. The sub-heater 242 functions for temperature adjustment for stabilizing the ink ejection property, and

cyan. The color of the first ink (magenta in this case) normally tends to be dominant, that is, the color is relatively closer to the burgundy color, at the dot position 120.

[0089] In this manner, the blue relatively closer to burgundy (burgundy blue) and the blue relatively closer to violaceous (violaceous blue) are always appear as a pair. Microscopically, the differently colored dot columns appear alternately. When this is seen on the pixel 130 macroscopically, the order of shots (applications) of the ink is the cyan dot from C2, the magenta dot from M2, the magenta dot from the M1 and the cyan dot from C1 in the backward path, and is the cyan dot from C1, the magenta dot from M1, the magenta dot from M2, cyan dot from C2. The order is symmetrical in the pixel. Therefore, in the single pixel, the intermediary blue color can be uniformly provided.

[0090] In this invention, when the maximum density is to be provided at a pixel, it is dominant that colors constituting a secondary color for a pixel are symmetrically printed for the pixel. In this example, the blue color (cyan and magenta) is taken as the secondary color, it will be readily understood that present invention is applicable to the red (magenta and yellow) and to the green (cyan and yellow). Moreover, it will be also readily understood that in the case of a process color, that is, tertiary color, and the similar effects can be provided when the colors are symmetrically printed.

[0091] Figure 6 shows an example in which the use is made with the head cartridge 1 having the same structure as with Figure 3, and the cyan and magenta dots are allotted to the dot position 121 on the pixel 130.

[0092] In this case, almost all of the different color inks are printed dot-on-dot for the pixel structures.

[0093] At the dot position 121, the order of the printing action in the forward path is such that dot from the cyan ejection nozzle 111 of the recording head 105C2, the dot from the magenta ejection nozzle 113 of the recording head 104M2, the dot from the magenta ejection nozzle 112 of the recording head 101M1, the dot from the cyan ejection nozzle 110 of the recording head 100C1 on the print medium. In the backward path, the cyan dot from C1, the magenta dot from M1, the magenta dot from M2, the cyan dot from C2 in a symmetrical pixel structure. Therefore, the blue coloring is more uniform in each pixel.

[0094] Again, when the maximum density is to be provided at a pixel, it is dominant that colors constituting a secondary color for a pixel are symmetrically printed for the pixel.

[0095] Figure 7 shows a data buffer structure of the printing apparatus according to this embodiment.

[0096] In this figure, a printer driver 211 is actuated by a program for generating image data in a host apparatus 210 and for supplying the generated data to the printing apparatus. The controller 200 converts the image data supply from the he printer driver 211 if necessary and distributes them as 2bit data for each color (CMY). The distribution circuit 207 write the data for each of CMY colors in the print buffer 205 in accordance with a correspondence table as shown in Figure 9 which will be described hereinafter.

[0097] For example, 2bit data are written for the cyan color. In the type of the embodiment, when the density is the maximum, 1bit data is written in the buffers 205C1, 205C2 for the recording heads 100C1 and 105C2, respectively. When the recording heads reach the predetermined positions for the recording for the pixels, the data in the buffer are read in the registers in the recording heads to effect the printing operations. By such data and the buffer structure, the printing can be effected on the subpixels from the different recording heads, for the 2 dot pairs. Here, the CMY is taken, but the same applies to the case of CMYK, to the case of light and dark inks or other colors.

[0098] The print buffers 205C1, C2, M1, M2, Yl, Y2 are provided in the RAM205.

[0099] Heretofore, the description has been made as to the case of reproducing the maximum density for each of the pixels. Now, the bi-directional print for reproducing the half-tone in a pixel will be described. Here, a specific example will be described in which multi-value data are received.

[0100] In this embodiment, three-value data (the number of dots is 0, 1 or 2) for each one component color corresponding to each color. The number of bits is not limited to 2 bit, but may be 4 bit or the like. Furthermore, even when the 2 bit data are used, only two values of them may be used. Particularly, the bit number is determined in view of the relation between the recording resolution and the dot diameter from the standpoint of the design philosophy of the degrees of the tone gradation for each pixel and the maximum density, and the present invention is usable with any of them.

[0101] When the half-tone is reproduced in a pixel, the 2-dot pair cannot be allotted in the pixel, since the 2-dot pair expresses the maximum density. In the embodiment of the present invention, in the case of the half-tone not allotting the dots in the 2-dot pair fashion, each color may contain only one dot. Therefore, when the secondary color is reproduced using the forward path and the backward path, the problem stemming from the penetration difference of coloring may arise because of the principle described in the introductory part of the specification.

[0102] In this embodiment, the control is effected such that occurrence probabilities of pixels in which the order of shots or deposition of the colors are different are substantially the same in the forward path and in the backward path, by which the coloring as seen macroscopically is the same in the forward path and the backward path. In this embodiment, the recording head is such that nozzles for each color provide a symmetrical order of shots with respect to the main scan direction to switch the order of shots in the recording scan. The order of shots can be changed in one main recording scan by

are the positions allotted to the dot ejected from the ejection nozzle 110 of the recording head 100C1 and the dot ejected from the ejection nozzle 111 of the recording head 105C2 in the pixel (pixel) 130 area. Here, the dot position 121 is an upper left position of the diagonal line, and the dot position 122 is a lower right position thereof. Designated by R11, R12 are main-scanning lines for forming a pixel 130 (raster line). In this example, one pixel is printed by 2 raster lines.

[0120] In the forward path in which the head cartridge 1 moves in the direction indicated by an arrow in Figure 12, the order of the shots to the pixel 130 is the recording head 105C2 and then 100C1, and in the backward path, the order is C1 and then C2. In the case of the primary color, the same color inks are deposited, and therefore, there occurs no difference in coloring due to the order of shots. In this Figure, the dot position 121 and the dot position 122 are not shown as being overlapped, but actually, as shown in Figure 13, the dots are partly overlapped in normal situations.

[0121] Figure 14 illustrates a case in which they use is made with a head cartridge 1 having the same structure as with Figure 12, and the dots are allotted to the dot positions 121, 123 on the pixel 130. In such a case, the dots are for the same primary color, so that no difference in the coloring occurs between the forward path and the backward path.

[0122] Figure 15 illustrates a case in which a head cartridge having the same structure as with Figure 12, the cyan and magenta dots are allotted to the dot positions 121, 122 on the pixel 130. In such a case, as is different from the pixel 130 structure shown in Figure 12, the dot-on-dot structure is provided for each color and for each pixel. Similarly to the case of Figure 6 (Embodiment 1), a uniform coloring property is provided for each pixel 130.

[0123] Microscopically, the differently colored pixels are alternately arranged for each rasters. But, macroscopically, the pixel structure is symmetrical in the order of shots, more particularly, the cyan dot form C2, the magenta dot from M2, the magenta dot from M1 and cyan dot from C1 in the forward path, and the cyan dot from C1, the magenta dot from MI, magenta dot from M2 and cyan dot from C2 in the backward path. Therefore, as for the unit of pixel, the intermediate blue coloring is uniformly provided.

[0124] In the present invention, it is important in the present invention that when the density of the pixel is maximum, it is dominant that different color inks are shot to the pixel in a symmetric fashion. Similarly to Embodiment 1, the uniform coloring property can be provided at all times at the pixel 130.

[0125] When the maximum density for the pixel is to be provided, it is desirably dominant that order of shots of colors forming the secondary color is symmetrical in a pixel. In this example, the blue (cyan plus magenta) is taken as an example of the secondary color, but the same applies to the red (magenta plus yellow) or to the green (cyan plus yellow).

[0126] Figure 16 illustrates a case in the use is made with a head cartridge 1 having the same structure as the head cartridge shown in Figure 12, and the dot is allotted to the dot position 121 and the dot position 123 of the pixel 130 in a dot-on-dot fashion for each color. In the situation, similarly to Figure 15, the coloring property is uniform as for the pixel 130.

[0127] The description has been made as to the case in which the maximum density is reproduced in each pixel. Now, the reproduction using bi-directional print for reproducing the half-tone in the pixel will be described. More particularly, multi-value data are received in this example. The multi-value data and the change of the order of shots are the same as with the foregoing embodiment, and therefore, the description therefor is omitted.

[0128] Figure 17 shows a conventional example in which the used recording nozzles are synchronised due to synchronism between the recording data to be subjected to the bi-directional print and the positions of the recording nozzle arrays. On rasters R1 R5, colorings of the dots at a column position when a half-tone, lateral line or hatching is printed at the dots having blue dot data (cyan and magenta).

[0129] In the forward path, the magenta (M) ink is first printed, and the cyan (C) ink is then printed, but in the backward path, vice versa. The difference in the coloring still occurs depending on the print data between the forward path and the backward path even if the yellow, magenta, cyan heads are arranged symmetrically.

[0130] As will be understood from the Figure, when the blue (mixture of cyan and magenta colors) is printed, there occurs dots in which the order of shots is the same, in each of the forward path and the backward path, with the result of color non-uniformity in the form of bands in the scanning direction.

[0131] Figures 19, 20 show the bi-directional printing in the embodiment. In this embodiment, the distribution circuit 207 having been described in the foregoing distributes or allots the data of respective colors to the dot positions, as shown in Figure 18. The dot allocation of Figure 18 is similar to Figure 9, and therefore, the detailed description is omitted. As for the magenta (M) in Figure 18, the arrangement of the recording heads M1, M2 is deviated by 1/2 dot pitch, and therefore, the head and dot positions are opposite from those of Figure 9.

[0132] In Figure 18, the blue dot allocations which is a secondary color of cyan plus magenta has been described, but the same applied to the yellow and the other secondary colors (green and red).

[0133] Figure 19 shows a state in which the bi-directional print is carried out through a method of this embodiment when the cyan and magenta data 01 are contained uniformly for each color in a pixel. In such a state, the order of shots are reversed for each column having the data (C2 and then M1; and M2 and then C1), and therefore, substantially macroscopically uniform color

usable if the advantageous effects of the present invention are provided.

[0148] Figure 25 shows an example having a recording head for the black color in addition to the structure shown in Figure 12. The black is generally not used for printing the secondary color, and therefore, there is no need of symmetrical arrangement. In order to permit a higher speed printing operation in a monochromatic recording mode, the number of the nozzles for the black color is larger than that of the other chromatic head.

[0149] Figure 26 shows an example having a structure similar to that of Figure 3 but additionally having black recording heads for ejecting black (K) ink at the respective ends, wherein only one yellow (Y) head is provided at the canter of symmetry to simple the structure. The recording head provided at the center of symmetry, ejects the ink later at all times, that is, irrespective of the scanning directions. In this example, the yellow is disposed at the center, but this is not limiting.

[0150] Figure 27 shows an example having a similar structure as with Figure 26, but it has only one recording head for the black (K) color printing, for the same reason as with Figure 25 example.

[0151] Figure 28 shows an example having only one yellow head at the center of symmetry in the structure of Figure 3, so that structure is simplified.

[0152] Figure 29 show an example which is similar to Figure 25 example but in which only one black head is provided at the center of symmetry.

[0153] As described in the foregoing, in each of the embodiments of the present invention, firstly as regards the low density portion, means is provided to make the incidence probabilities of the orders of shots of at least different colors in the forward path print are the same as those in the backward path print at least for the pixels where different color dots are combined, and secondly, as regards the high density portion, means is provided to make it dominant that at least when secondary or higher color is to be formed, the order of shots of the color inks is symmetrical wherein for at least one of the color inks used, a pixel is printed by two dots.

[0154] Therefore, the differences in the coloring which has conventionally caused by the synchronism with image data such as a line or the like and by the difference in the shot order at the high density portion can be avoided. Furthermore, the color non-uniformity attributable to synchronism with half-toning using dither method or the like in the half-tone portion and the low density portion can be suppressed.

[0155] The present invention is particularly suitably usable in an ink jet recording head and recording apparatus wherein thermal energy by an electrothermal transducer, laser beam or the like is used to cause a change of state of the ink to eject or discharge the ink. This is because the high density of the picture elements and the high resolution of the recording are possible.

[0156] The typical structure and the operational principle are preferably the ones disclosed in U.S. Patent Nos. 4,723,129 and 4,740,796. The principle and structure are applicable to a so-called on-demand type recording system and a continuous type recording system. Particularly, however, it is suitable for the on-demand type because the principle is such that at least one driving signal is applied to an electrothermal transducer disposed on a liquid (ink) retaining sheet or liquid passage, the driving signal being enough to provide such a quick temperature rise beyond a departure from nucleation boiling point, by which the thermal energy is provided by the electrothermal transducer to produce film boiling on the heating portion of the recording head, whereby a bubble can be formed in the liquid (ink) corresponding to each of the driving signals. By the production, development and contraction of the the bubble, the liquid (ink) is ejected through an ejection outlet to produce at least one droplet. The driving signal is preferably in the form of a pulse, because the development and contraction of the bubble can be effected instantaneously, and therefore, the liquid (ink) is ejected with quick response. The driving signal in the form of the pulse is preferably such as disclosed in U.S. Patents Nos. 4,463,359 and 4,345,262. In addition, the temperature increasing rate of the heating surface is preferably such as disclosed in U.S. Patent No. 4,313,124.

[0157] The structure of the recording head may be as shown in U.S. Patent Nos. 4,558,333 and 4,459,600 wherein the heating portion is disposed at a bent portion, as well as the structure of the combination of the ejection outlet, liquid passage and the electrothermal transducer as disclosed in the above-mentioned patents. In addition, the present invention is applicable to the structure disclosed in Japanese Laid-Open Patent Application No. 123670/1984 wherein a common slit is used as the ejection outlet for plural electrothermal transducers, and to the structure disclosed in Japanese Laid-Open Patent Application No. 138461/1984 wherein an opening for absorbing pressure wave of the thermal energy is formed corresponding to the ejecting portion. This is because the present invention is effective to perform the recording operation with certainty and at high efficiency irrespective of the type of the recording head.

[0158] The present invention is effectively applicable to a so-called full-line type recording head having a length corresponding to the maximum recording width. Such a recording head may comprise a single recording head and plural recording head combined to cover the maximum width.

[0159] In addition, the present invention is applicable to a serial type recording head wherein the recording head is fixed on the main assembly, to a replaceable chip type recording head which is connected electrically with the main apparatus and can be supplied with the ink when it is mounted in the main assembly, or to a cartridge type recording head having an integral ink container.

[0160] The provisions of the recovery means and/or the auxiliary means for the preliminary operation are

color pixel areas arranged in each raster line different from the order of another.

6. An apparatus according to Claim 5, wherein said forming means distributes the print data randomly to the print buffers on the basis of the image signal corresponding to the color image.

7. An apparatus according to Claim 5, wherein said forming means distributes the print data alternately to the print buffers on the basis of the image signal correspondingly to the color image.

8. An apparatus according to recording element, wherein said recording head includes recording elements for applying different color inks arranged in the scanning direction, and said changing means changes the order of applications of the inks to the pixel areas by selecting a scanning direction of the recording head in which the ink is applied to the pixel areas.

9. An apparatus according to Claim 3, wherein the recording elements includes at least cyan, magenta and yellow ink recording elements, and one of such recording elements is at a center of the symmetry.

10. An apparatus according to Claim 3, wherein a number of the sets is two.

11. An apparatus according to Claim 9 or 10, wherein said recording head further includes a recording element for applying black ink.

12. An apparatus according to Claim 1, further comprising means for applying to the secondary color pixel area a plurality of at least one of the color inks to be applied to form the secondary color to make the order of applications of the inks of said one of the color inks symmetrical to that of the other color.

13. An apparatus according to Claim 12, wherein a plurality of the other ink is applied to the pixel area.

14. An apparatus according to Claim 12, wherein centers of gravity of the dots of the different colors applied to the pixel area are substantially aligned with each other.

15. An apparatus according to Claim 12, wherein dots of inks of different colors applied to the pixel area are at least partly overlapped.

16. An apparatus according to Claim 13, wherein a plurality of the dots of the one color ink and a plurality of dots of the other color inks applied in a different order are provided in said pixel area.

17. A printing apparatus for forming a color image by application of different color inks onto a printing material while bi-directionally moving the recording head to scan the printing material, said recording head having one or more sets of recording elements arranged in a scanning direction symmetrically, said apparatus comprising:

print buffers each corresponding to the symmetrically arranged recording elements constituting the set; and
distributing means for distributing print data for a color to at least one of the print buffers on the basis of an image signal corresponding to the color image.

18. An apparatus according to Claim 17, wherein said distributing means distributes the print data to either one of the print buffers when the image signal has a low level, and distributes the print data to both of the print buffers when the image signal has a high level.

19. A printing apparatus for forming a color image by application of different color inks to a printing material while bi-directionally moving the recording head to scan the recording material, said apparatus comprising:

changing means for changing an order of applications of inks of different colors to formation a process color in a process color pixel area;
forming means for forming the process color by making an order of applications of the inks to at least of the secondary color pixel areas arranged in a raster one direction different from the order of another, by said changing means.

20. An apparatus according to Claim 1 or 19, wherein the recording head ejects he ink by heat.

21. A printing method for forming a color image by application of different color inks onto a printing material while bi-directionally moving the recording head to scan the printing material, said method comprising:

a first step of application of different color inks to form a secondary color in a secondary color pixel area in an order of applications;
a second step of application of different color inks to form the secondary color in the secondary color pixel area in an order of applications which is different from the order in the first step;

22. A method according to Claim 21, wherein the recording head includes two sets of recording elements for application of the color ink, the recording

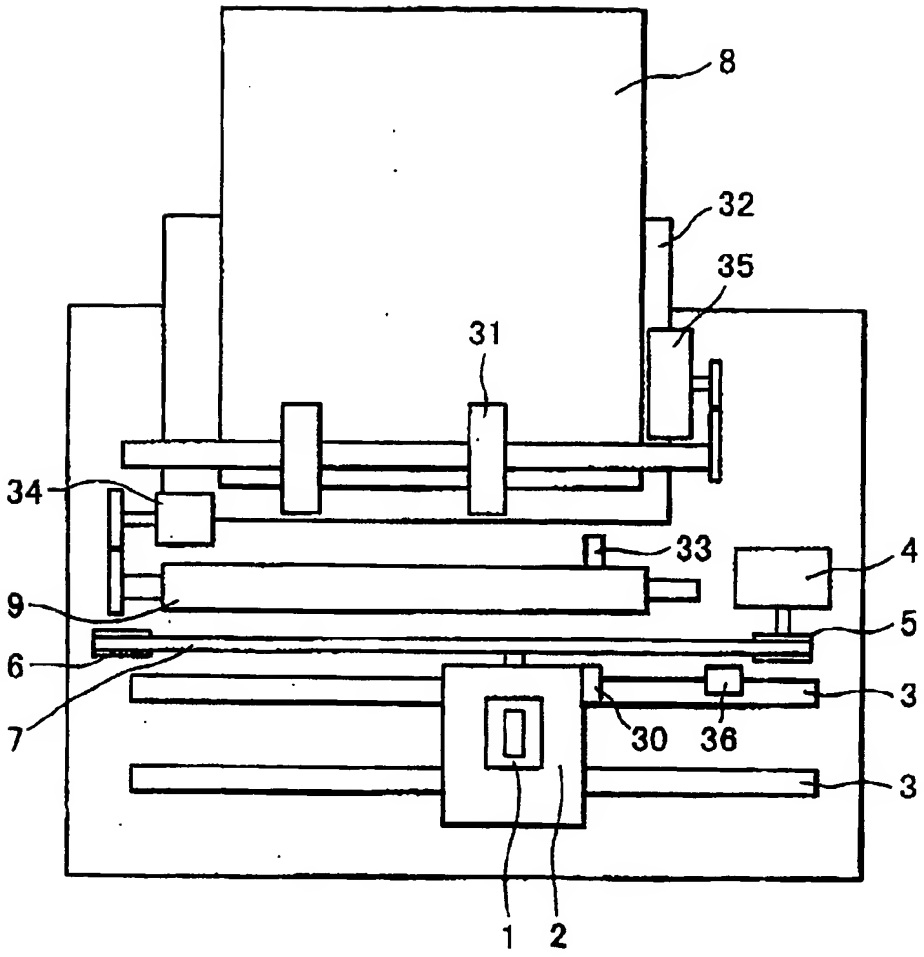

FIG. 1

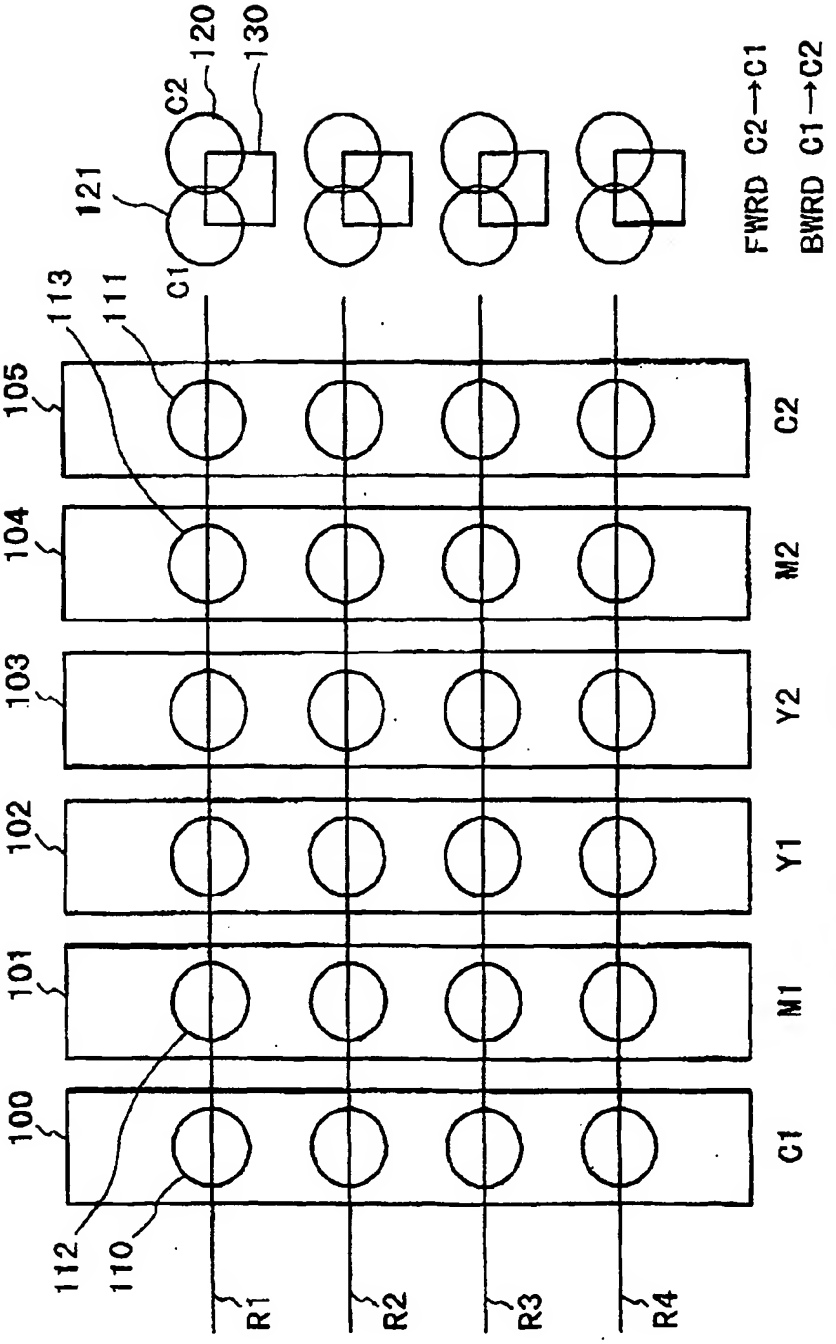
C2
120
130
121
C1
113
111
105
104
103
102
101
100
112
110
R1
R2
R3
R4
C1
M1
Y1
Y2
M2
C2
FWRD C2→C1
BWRD C1→C2
FWRD

FIG. 3

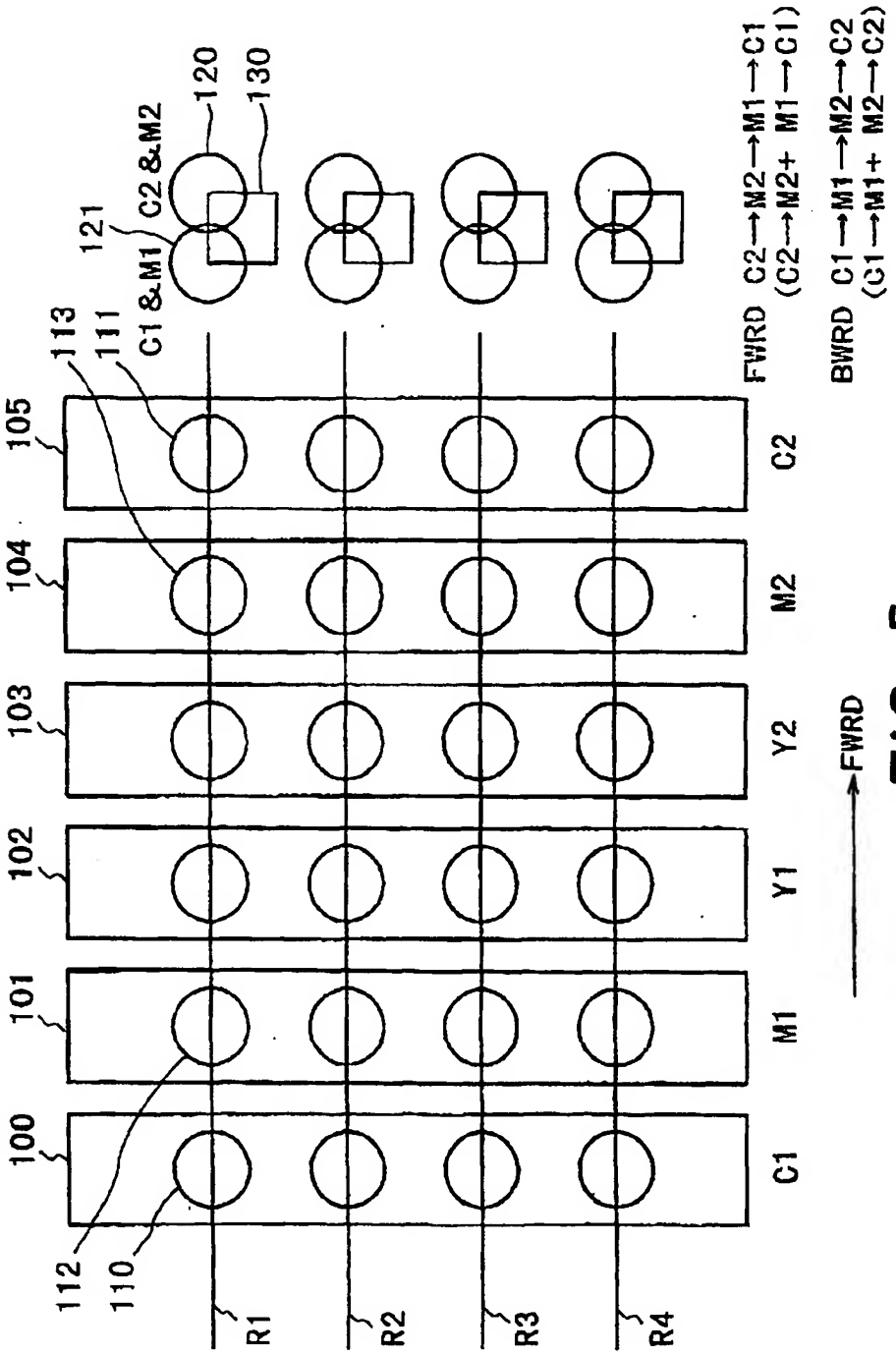
100
101
102
103
104
105
C1
M1
Y1
Y2
M2
C2
112
110
R1
R2
R3
R4
C1 &M1
C2 &M2
111
113
121
120
130
FWRD C2→M2→M1→C1
(C2→M2+ M1→C1)
BWRD C1→M1→M2→C2
(C1→M1+ M2→C2)
FWRD

FIG. 5

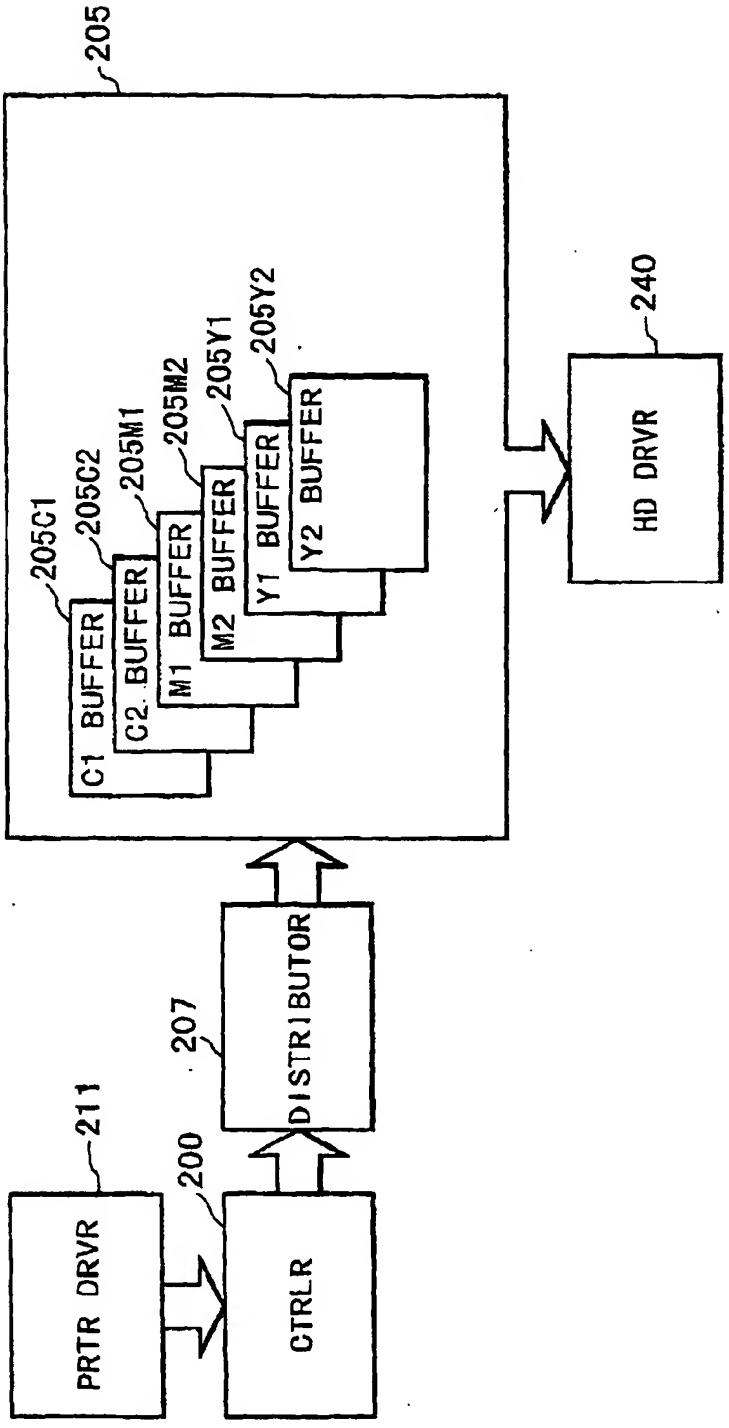
205
205C1
205C2
205M1
205M2
205Y1
205Y2
C1 BUFFER
C2 BUFFER
M1 BUFFER
M2 BUFFER
Y1 BUFFER
Y2 BUFFER
240
HD DRVR
207
DISTRIBUTOR
211
200
PRTR DRVR
CTRLR

FIG. 7

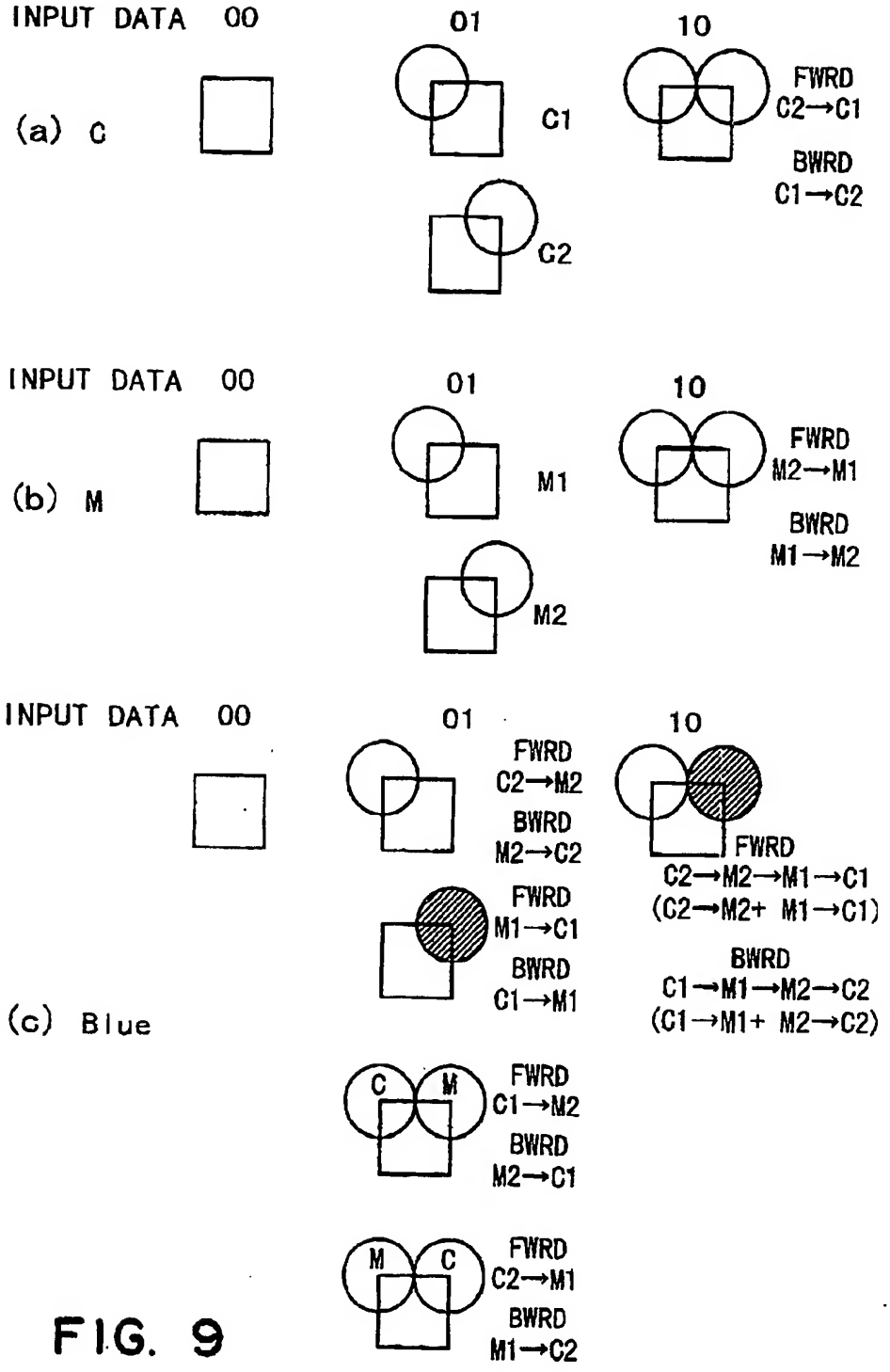
INPUT DATA 00
01
10
(a) C
C1
C2
FWRD
C2→C1
BWRD
C1→C2
INPUT DATA 00
01
10
(b) M
M1
M2
FWRD
M2→M1
BWRD
M1→M2
INPUT DATA 00
01
10
(c) Blue
FWRD
C2→M2
BWRD
M2→C2
FWRD
M1→C1
BWRD
C1→M1
FWRD
C2→M2→M1→C1
(C2→M2+ M1→C1)
BWRD
C1→M1→M2→C2
(C1→M1+ M2→C2)
C
M
FWRD
C1→M2
BWRD
M2→C1
M
C
FWRD
C2→M1
BWRD
M1→C2

FIG. 9

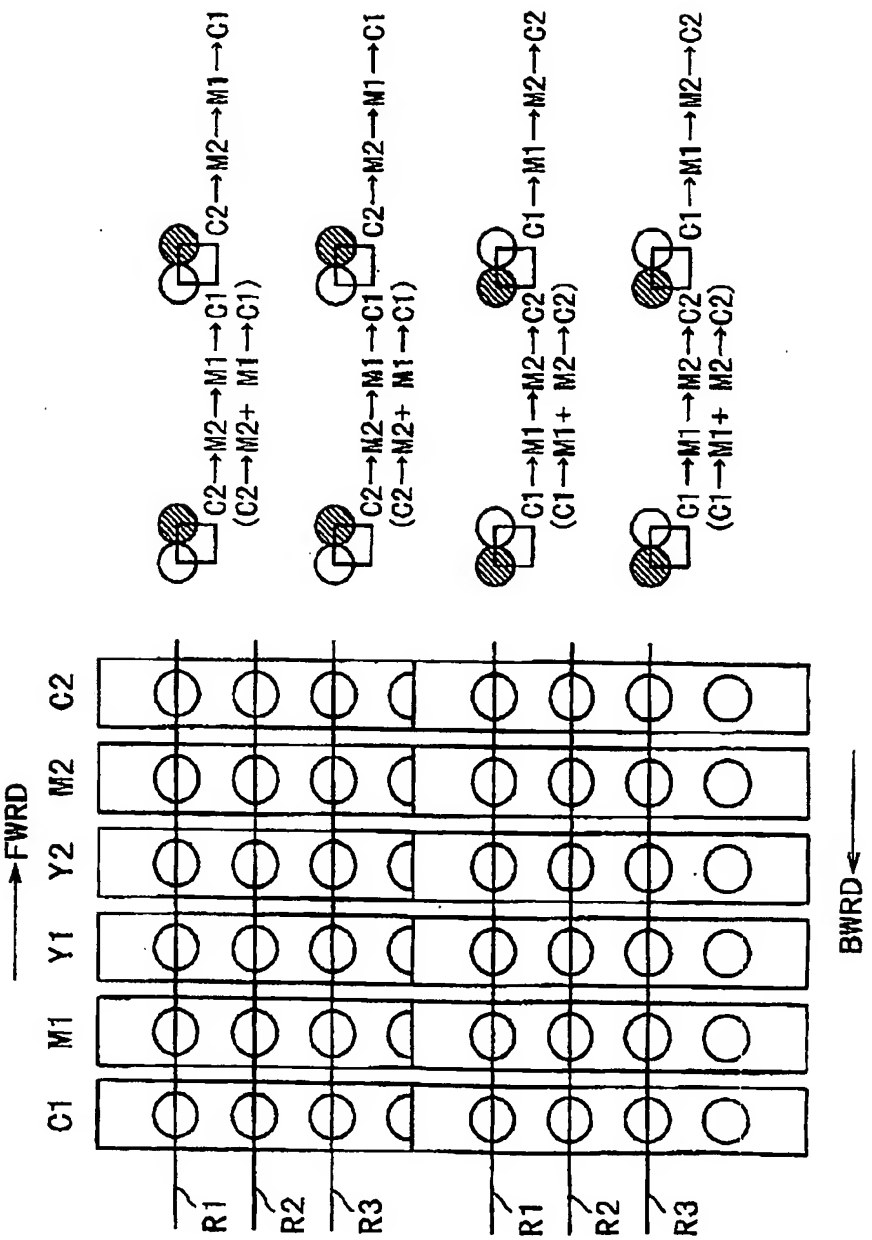
FWRD
C1
M1
Y1
Y2
M2
C2
R1
R2
R3
R1
R2
R3
BWRD
C2→M2→M1→C1
C2→M2→M1→C1
(C2→M2+ M1→C1)
C2→M2→M1→C1
C2→M2→M1→C1
(C2→M2+ M1→C1)
C1→M1→M2→C2
C1→M1→M2→C2
(C1→M1+ M2→C2)
C1→M1→M2→C2
C1→M1→M2→C2
(C1→M1+ M2→C2)

FIG. 11

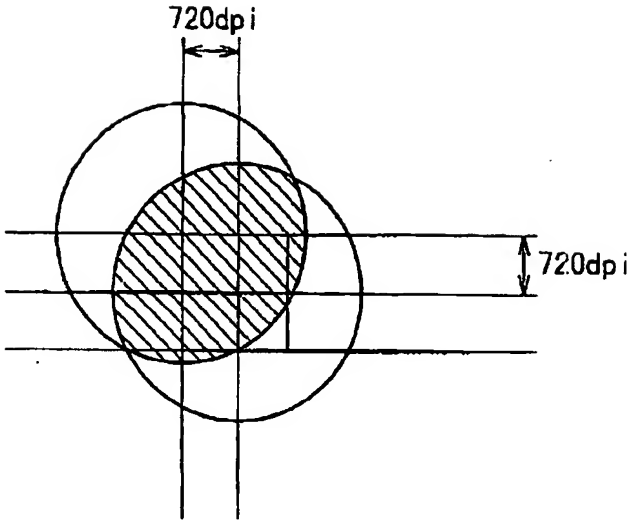

FIG. 13

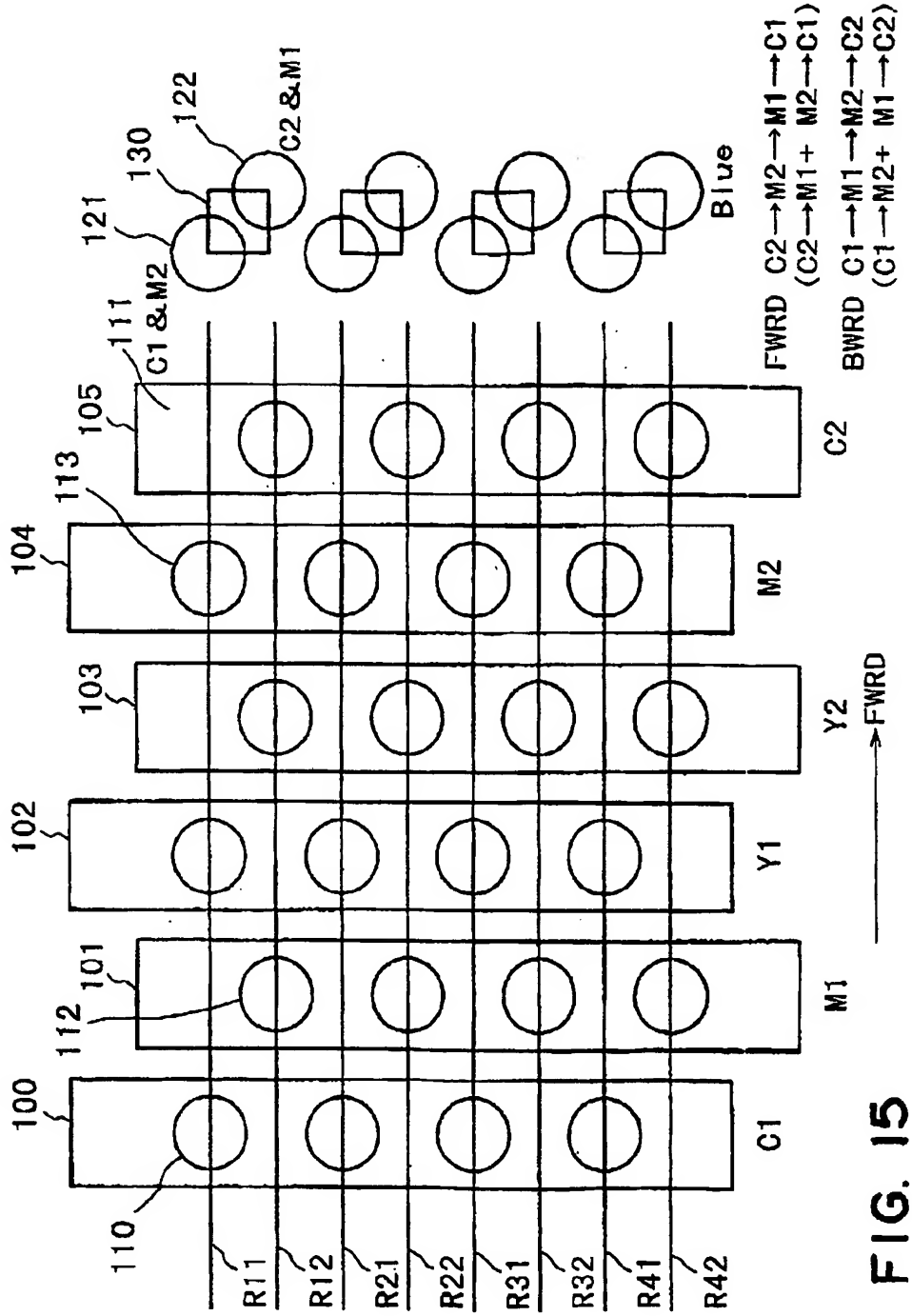
100
101
102
103
104
105
110
111
112
113
121
122
130
C1
C2
M1
M2
Y1
Y2
C1 &M2
C2 &M1
Blue
R11
R12
R21
R22
R31
R32
R41
R42
FWRD
BWRD
C2→M2→M1→C1
(C2→M1+ M2→C1)
C1→M1→M2→C2
(C1→M2+ M1→C2)
→FWRD

FIG. 15

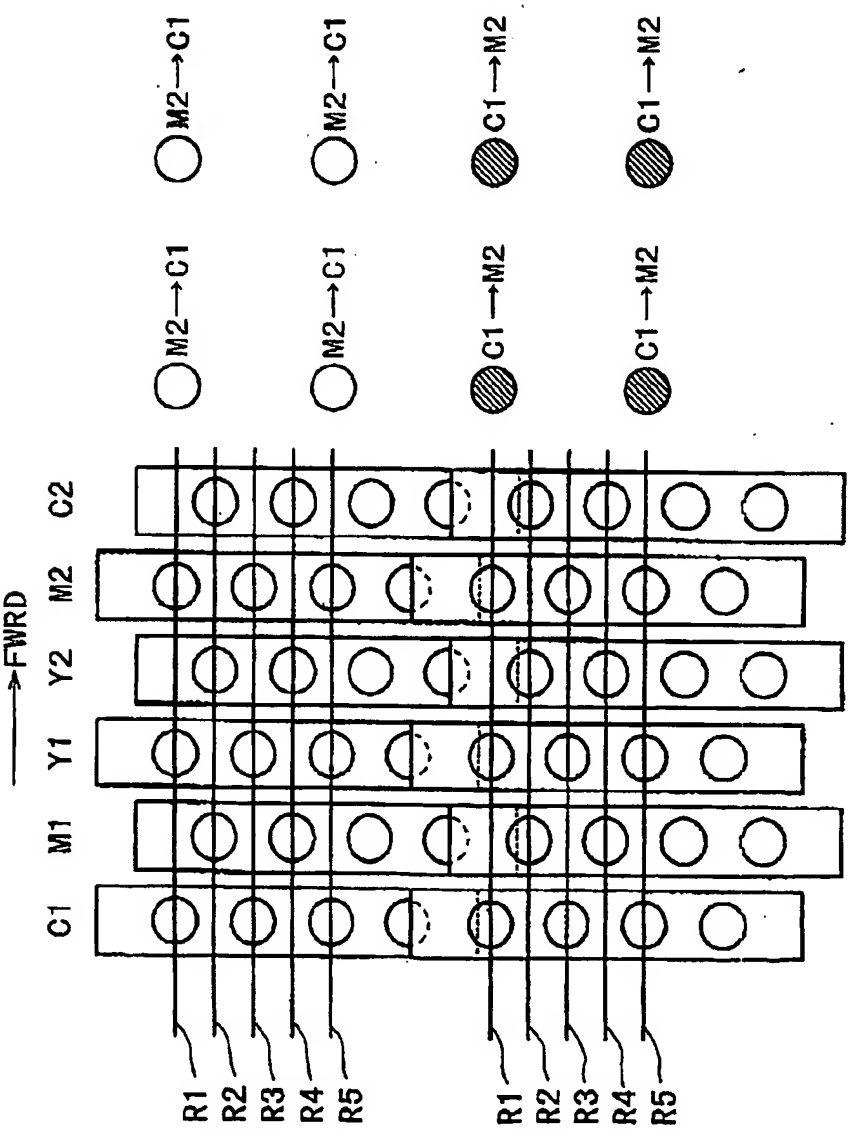
M2→C1
M2→C1
C1→M2
C1→M2
M2→C1
M2→C1
C1→M2
C1→M2
FWRD
BWRD
C1
M1
Y1
Y2
M2
C2
R1
R2
R3
R4
R5
R1
R2
R3
R4
R5

FIG. 17

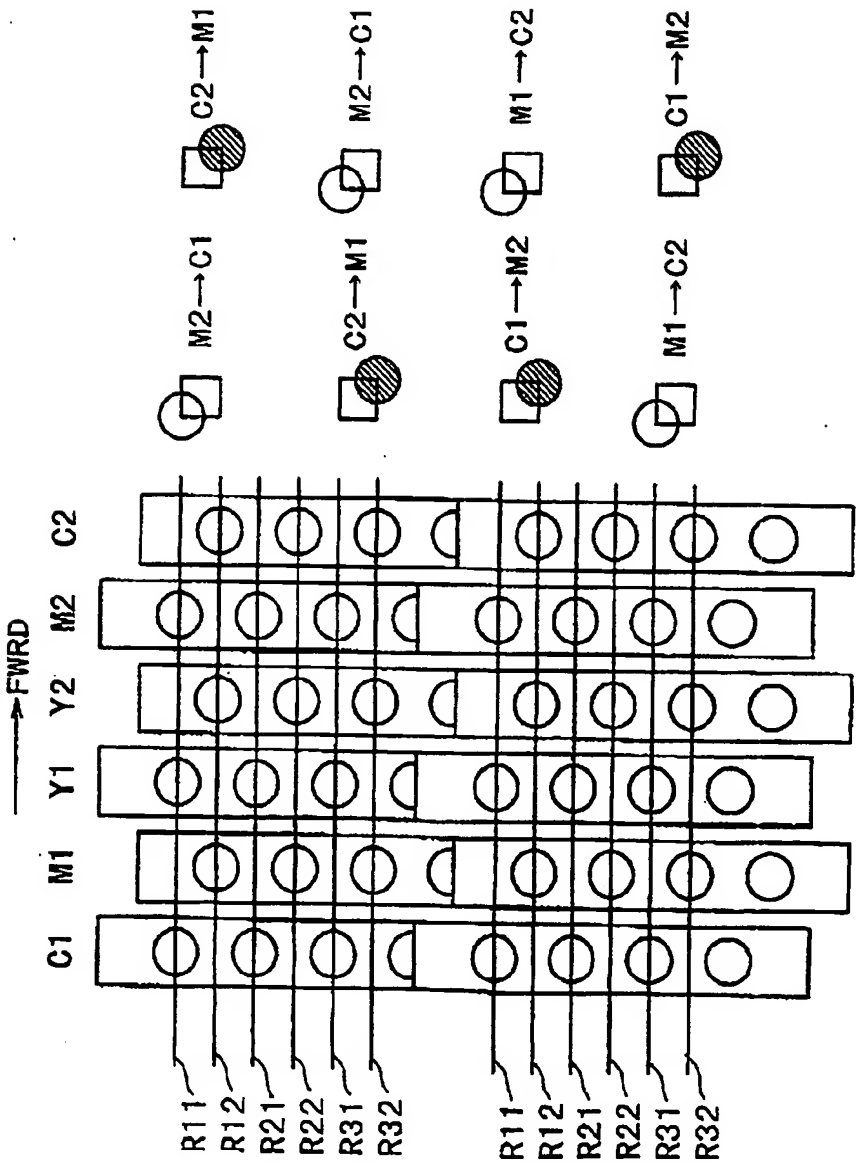
C2→M1
M2→C1
M1→C2
C1→M2
M2→C1
C2→M1
M1→C2
C1→M2
FWRD
BWRD
C2
M2
Y2
Y1
M1
C1
R11
R12
R21
R22
R31
R32
R11
R12
R21
R22
R31
R32

FIG. 19

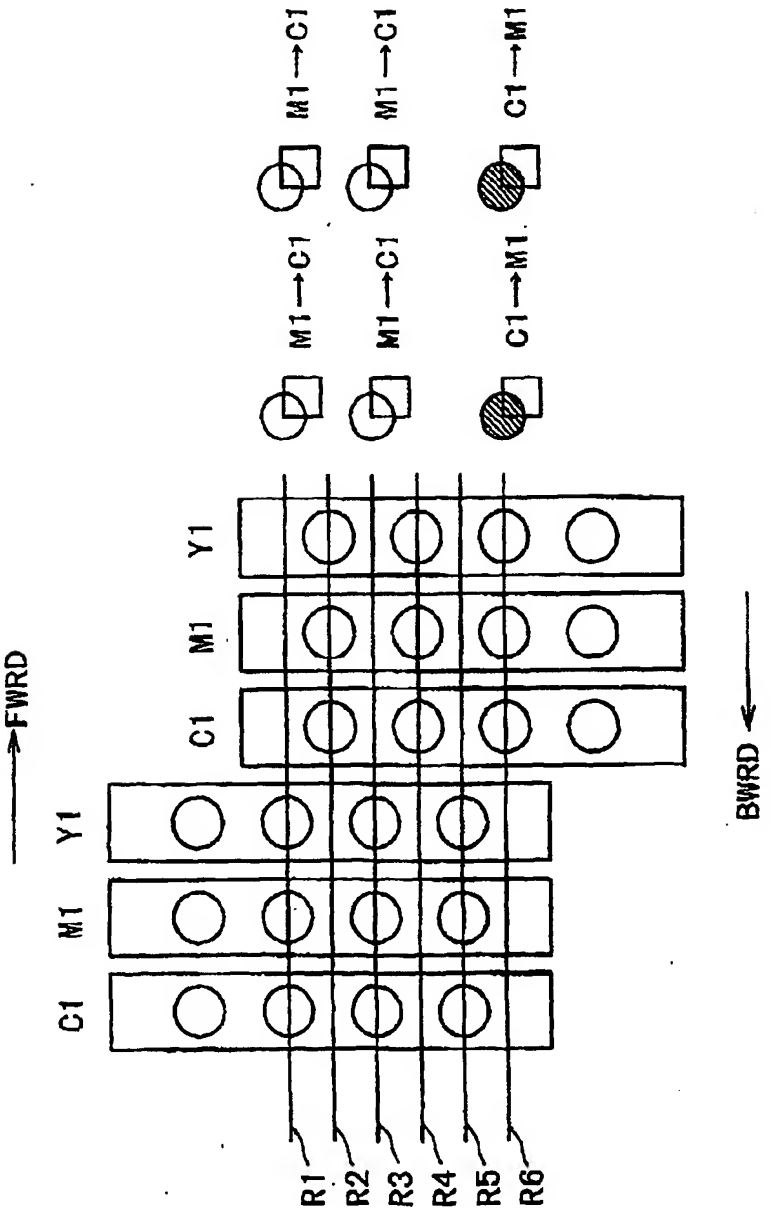
M1→C1
M1→C1
C1→M1
M1→C1
M1→C1
C1→M1
Y1
M1
C1
Y1
M1
C1
FWRD
BWRD
R1
R2
R3
R4
R5
R6

FIG. 21

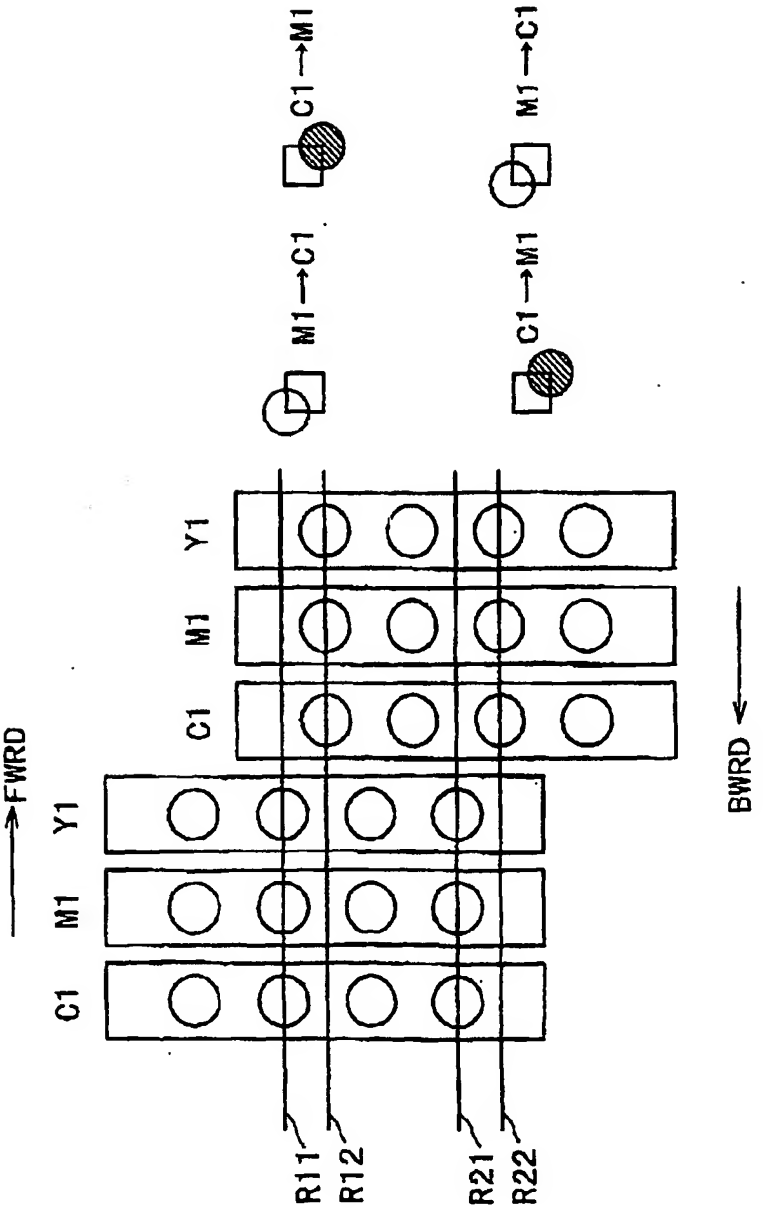

FIG. 23

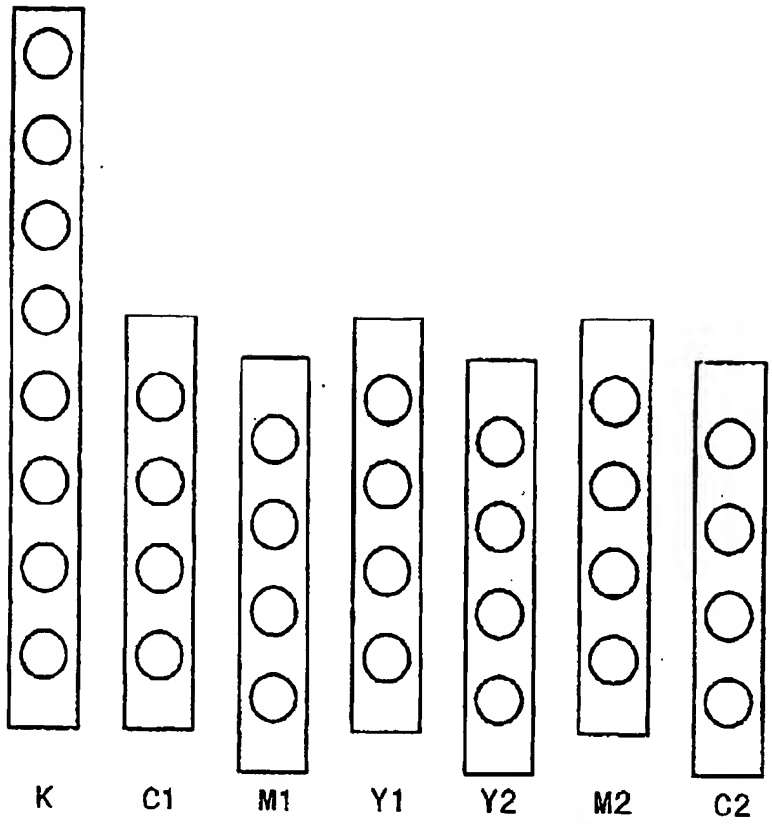

FIG. 25

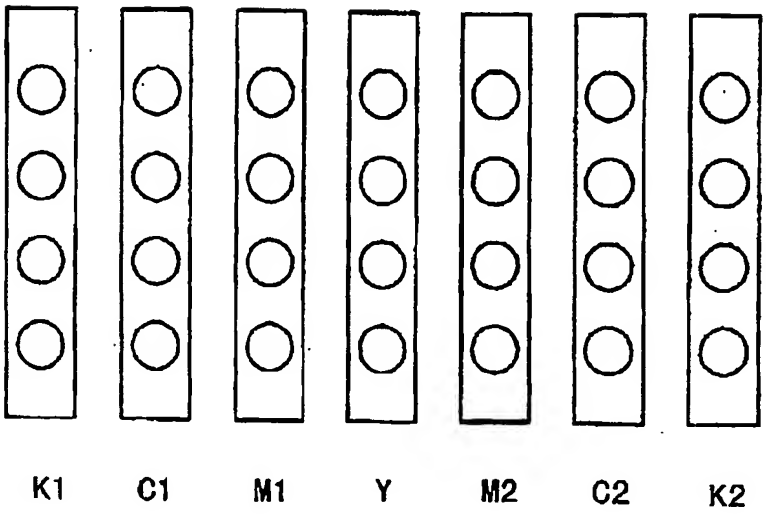

FIG. 26

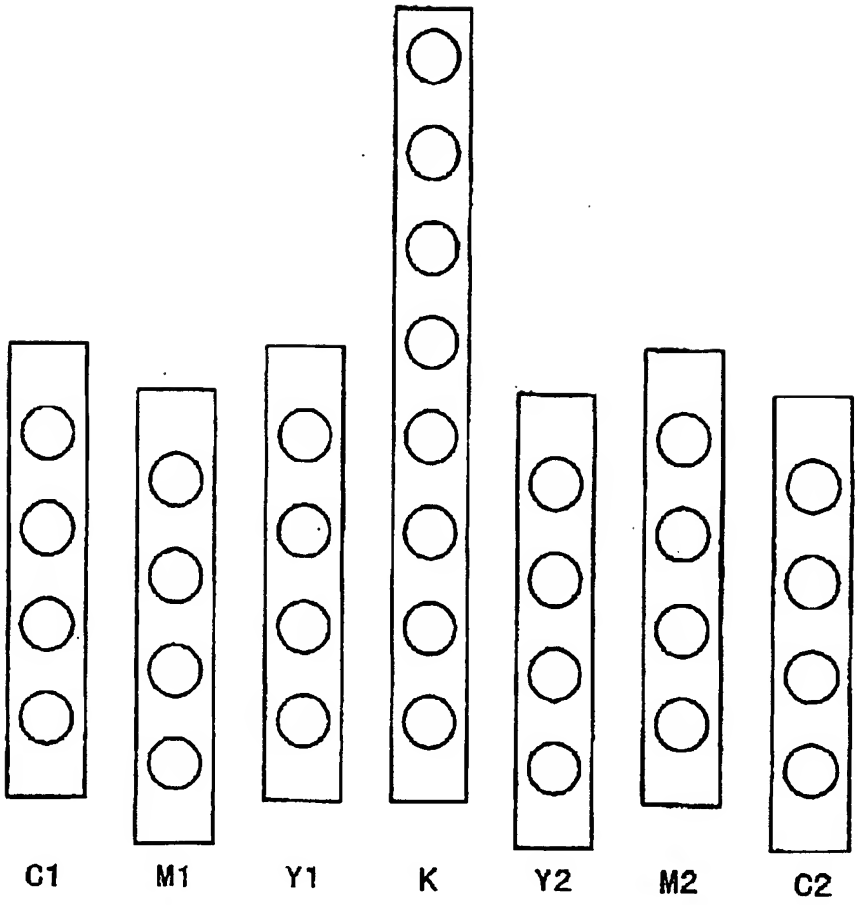

FIG. 29

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Office européen des brevets

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(54) Printing apparatus and printing method

(57) A printing apparatus for forming a color image by applying different color inks to a printing material while bi-directionally moving the recording head to scan the recording material, the apparatus includes changing means for changing an order of applications of the inks to be applied for printing a secondary color to a secondary color pixel area; forming means for forming the secondary color while making the order of applications of the inks to at least one of a plurality of the secondary color pixel areas arranged along a raster scan direction different from the order of another, by the changing means.

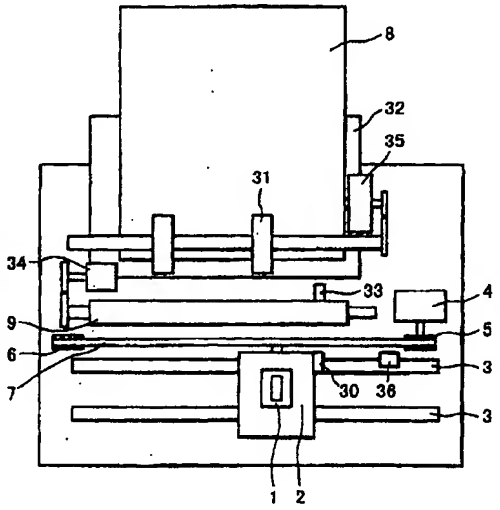

FIG. 1

EP 1 088 669 A3

European Patent Office

LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 00 12 1455

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. Claims: 1-16,19-26

   Printing apparatus and method, making order of application of of inks for mixed colours different between pixels of a raster scan direction.

2. Claims: 17,18

   Printer with symmetrically arranged recording elements, each with a corresponding print buffer.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 00 12 1455

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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07-06-2002

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5225849 A		DE 68911393 D1	27-01-1994
		DE 68911393 T2	14-07-1994
		EP 0347257 A2	20-12-1989

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82